PATENT

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Title: **DIRECTIONAL WASTEWATER AERATOR AND METHOD**

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Directional Wastewater Aerator and Method

Cross Reference to Related Application and Claim to Priority:

This application is based on provisional application Serial No. 60/409,185, filed September 10, 2002, for Willie B. McNeill, Jr., the disclosure of which is incorporated herein by reference and to which priority is claimed under 35 U.S.C. §120.

Field of the Invention:

The invention relates to a wastewater aerator having curved baffles to direct the wastewater in a desired direction.

Background of the Invention:

Conventional wastewater treatment facilities typically include a number of vessels or tanks, which are interconnected through pipes, pumps, and similar plumbing for treating wastewater. Some facilities may include a surge tank for smoothing fluctuations in wastewater input, and a number of subsequent processing tanks.

Treatment of wastewater at a conventional facility may involve three major stages. The primary treatment stage includes a settling tank, wherein the densest sludge of the wastewater is separated, and removed and sent to an incinerator. The remaining effluent then undergoes secondary treatment, which may involve the biochemical consumption of organic material in one or more basins. Aerobic microorganisms consume organic pollutants in wastewater. Because the bacteria are aerobic, their efficiency of consumption is dependent upon the level of oxygen dissolved in the wastewater. The higher the level of dissolved oxygen in the effluent, the faster the rate of

bacterial consumption of organic pollutants. As such, aeration of the effluent is desirable so that the bacteria efficiently consume the organic wastes. Tertiary treatment may be simple or extensive depending on the extent of pollution and the local requirements for water purity. Inorganic pollutants may be removed during tertiary treatment, as well as any organic pollutants not removed during the primary and secondary stages.

To achieve adequate aeration for consumption of the organic pollutants, aeration basins may include aerator devices or systems for adding oxygen to the effluent. One conventional wastewater treatment facility is disclosed in U.S. Patent No. 5,110,465, for Willie B. McNeill, Jr., the inventor of which is the inventor the present invention, and the disclosure of which is incorporated herein by reference. In the '465 patent, this disclosed facility comprises an optional surge basin, an aeration basin, a settling basin, and a digester basin. Each basin has an assembly for supplying fluid treated therein to the next interconnected basin. An aerator is provided in the aeration basin for causing fluid flow thereabout.

Various aerator devices have been developed for use in aeration basins, including brush aerators, paddle wheel type aerators and horizontal aerators. Such devices fail to effectively pull wastewater from the bottom of the aeration basin, where the concentration of dissolved oxygen is relatively low. As such, they fail to effectively aerate and mix the fluid in the vessel.

Other devices draw wastewater from the vessel, and spray the wastewater throughout a 360° direction above the wastewater surface. Such devices require a relatively large amount of energy. Therefore, they are not cost efficient. In addition, concrete guides are typically required within the basin so that wastewater flow may be

controlled and contained within a particular area of the basin. Such guides further increase system complexity and cost.

Therefore, there is a need for an aerator device that directs the wastewater flow path when the wastewater is being discharged from the aerator device, which effectively mixes and aerates the wastewater, and that is cost efficient.

Summary of the Invention:

A directional aerator comprises a float, an uptake pipe extending through said float, and a means for pulling a flow of wastewater into the uptake pipe. The wastewater flow is vertically displaced upwardly through the uptake pipe. At least one pair of baffles deflects the flow of wastewater upon discharge.

A method of aerating a fluid is disclosed. A floating aerator having an uptake pipe is provided. Fluid is pulled into the uptake pipe, and vertically displaced upwardly through the uptake pipe. The flow of fluid is deflected in a selected direction upon discharge, forming an aeration ditch.

Description of the Drawings:

Figure 1 is a side elevational view, with portions shown in phantom, of a directional aerator according to a first embodiment of the present invention;

Figure 2 is a cross-sectional plan view, with portions shown in phantom, of a directional aerator according to the first embodiment;

Figure 3 is a cross-sectional plan view, with portions shown in phantom of a directional aerator according to the first embodiment with flow path arrows;

Figure 4 is a top plan view of an aeration basin with directional aerators according to the present invention;

Figure 5 is a cross sectional view of the aeration basin of Figure 4 taken along line 5-5 and viewed in the direction of the arrows;

Figure 6 is a side elevational view, with portions shown in phantom, of a directional aerator according to a second embodiment;

Figure 7 is an exploded assembly view of a directional aerator according to the second embodiment;

Figure 8 is a top plan view of a directional aerator according to the second embodiment with flow path arrows;

Figure 9 is a top plan view of a directional aerator according to the second embodiment; and

Figure 10 is a top plan view of a directional aerator according to the second embodiment with flow path arrows.

Detailed Description of the Invention:

As best shown in Figure 1, a directional aerator 10 according to one embodiment of the present invention comprises a float 12, which maintains buoyancy on the wastewater surface 14 within an aeration vessel or area. Float 12 has a first major surface 16 and a second major surface 18, with side surfaces 20 therebetween. An uptake pipe 22 extends through first and second major surfaces 16 and 18 of float 12. Uptake pipe 22 includes a lower portion 24, which extends downwardly from second major surface 18 and into the wastewater below wastewater surface 14. Uptake pipe 22 also includes an

upper portion 26, which extends upwardly toward first major surface 16, above wastewater surface 14. Preferably lower portion 24 includes a curved end or elbow portion 28. Elbow portion 28 may be substantially parallel with first and second major surfaces 16 and 18 of float 12. Elbow portion 28 includes an intake 29 into which fluid is pulled. Intake 29 may be substantially perpendicular to lower portion 24.

The length of lower portion 24 may be adjusted depending on the system requirements. For example, a relatively long lower portion 24 may be required for deep basins or ponds in order to place intake 29 closer to the bottom of the basin. The length of lower portion 24 may be adjusted at the time of manufacture depending on customer specifications. Lower portion 24 may then be welded onto aerator 10. Alternatively, lower portion 24 and elbow portion 28 may be joined by a flange or conventional spacer used to connect pipes. A standard length for lower portion 24 may be provided when aerator 10 is constructed, for example twenty-four inches in length. If a longer uptake pipe 22 is required, elbow portion 28 may be removed, and an extension pipe joined between and interconnecting lower portion 24 and elbow portion 28.

Intake 29 draws wastewater from the deepest portion of the vessel, where there is normally the least amount of oxygen. The wastewater is vertically displaced upwardly through uptake pipe 22, and then discharged above wastewater surface 14 so that aeration may occur. It is more efficient to add oxygen to a liquid having a relatively low dissolved oxygen level, compared to adding oxygen to a liquid with a higher dissolved oxygen level. This is because the aerobic bacteria only use a limited amount of oxygen during the consumption process. If more oxygen than the bacteria can use is provided through inefficient aeration methods, the excess aeration represents an unnecessary cost

in energy required for running the aerator. Drawing wastewater from near the bottom of the vessel, where dissolved oxygen level is the lowest in the basin, is therefore an efficient method of aerating and mixing the wastewater.

Aerator 10 may include an impeller 30 operably associated with a motor 32 to pull the wastewater into intake 29, as show by arrows F. Preferably, motor 32 is a sealed electric motor, which typically requires a minimal amount of maintenance. For example, sealed electric motor 32 may require lubrication once per year, or possibly once about every eight months if motor 32 is operated 24 hours a day, seven days a week. The horsepower (hp) of motor 32 is dependent on system requirements, but may be in the range of between about 3 hp to about 75 hp. In addition, the diameter of float 12 may vary, and also may affect the hp requirements of motor 32. For example, a 20 hp motor 32 may be fitted to a float 12 having a diameter of about 7 feet. A 40 hp motor 32 may be fitted to a float 12 having a diameter of about 9 feet. Thus, as the hp of motor 32 increases, the diameter of float 12 preferably increases.

Generally, no lubrication is required for other components of aerator 10. An impellor shaft 31 connects impeller 30 with motor 32. Other means for pulling fluid through aerator 10 may also be used, such as a pump. Impeller 30 may be positioned within uptake 22 adjacent second major surface 18, so that impeller 30 is just below wastewater surface 14. A motor base plate 33 may be provided, so that wastewater is not pulled into motor 32.

As best shown in Figures 1 and 2, directional baffles 34 extend from uptake pipe 22, above first major surface 16 of float 12. Three pairs A, B and C of directional baffles 34 are shown in Figures 2 and 3. However, more or fewer baffles 34 may be provided,

depending on the particular system requirements. As such, pairs A, B, C are shown for purposes of explanation only, and the disclosed embodiment is not so limited.

Each of directional baffles 34 comprises a crescent-shaped plate, having a first end 36 and a second end 38. First ends 36 are secured to uptake pipe 22 adjacent first major surface 16 of float 12. Alternatively, first ends 36 may also be secured to a corresponding sleeve 40 surrounding a discharge outlet 42 of uptake pipe 22 adjacent first major surface 16. Preferably, pair C of directional baffles 34 is smaller than pair B, which is smaller than pair A.

The wastewater flow path F is vertically displaced upwardly toward directional baffles 34 by impellor 30, and directed outwardly therefrom in a desired direction, as best shown in Figure 3. Motor base plate 33 (the circumference shown in phantom in Figures 2-3) prevents wastewater from continuing upwardly toward motor 32. Directional baffles 34 are positioned so that second ends 38 point toward the desired direction of discharge, wherein second ends 38 of pair A are positioned in an outermost position relative to discharge outlet 42, pair C are positioned in an innermost position relative to discharge outlet 42, and pair B are positioned therebetween.

Wastewater is pulled into intake 29, and vertically displaced upwardly by impellor 30 to discharge outlet 42. As shown by arrows F indicating the flow path of discharging wastewater in Figure 3, the wastewater is deflected in a desired direction. Some wastewater exits discharge 42 already proceeding in the desired direction, and is simply deflected outwardly by motor base plate 33. Some wastewater is deflected into pair A of baffles 32, channeled between pairs A and B and motor base pate 33 toward ends 38, and then discharged outwardly from aerator 10. Some wastewater is deflected

into pair B of baffles 32, channeled between pairs B and C and motor base plate 33, and discharged outwardly from ends 38. Some wastewater is deflected by pair C and motor base plate 33, and discharged outwardly from ends 38.

The wastewater is discharged above wastewater surface 14 in a predetermined discharge pattern based on the orientation and angle of baffles 34 relative to discharge outlet 42. Wastewater may be discharged onto wastewater surface 14 in a single direction, which creates velocity in a circulation channel, or aeration ditch, as best shown in Figures 4 and 5.

A circulation basin B is provided, with the flow path and direction of wastewater shown by arrows F. The shape of basin B is for purposes of explanation only. Aerator 10 may be used in aeration vessels and tanks having various configurations, or even deep aeration ponds. Aerator 10 draws wastewater into intake 29 from near the bottom of the basin B, as best shown in Figure 5. The wastewater is then vertically displaced and directed from discharge outlet 42 in a desired direction, forming an aeration ditch in basin B.

An aeration ditch is a closed loop around which wastewater is circulated within basin B (or some other vessel) by aerator 10. Aeration ditches are very energy efficient because the momentum of the mass of wastewater causes a continuous motion, as best shown in Figure 4. Aerator 10 maintains a continuous wastewater flow using a relatively small amount of energy by pulling the wastewater from near the bottom of the vessel and directing the flow to form an aeration ditch. The created aeration ditch effectively mixes the fluid. In addition, wastewater is efficiently aerated since aerator 10 aerates the wastewater from near the bottom of the aeration basin B.

Conventional aeration systems typically require a relatively large amount of energy to achieve high levels of mixing and aeration, or fail to effectively aerate the wastewater from near the bottom of the vessel. In addition, many conventional systems include gearboxes and/or hydraulic drives, which are expensive and require a relatively large amount of maintenance. Many conventional systems also include long hollow shafts, which may be prone to bearing failures.

Aerator 10 eliminates the need for gearboxes and/or hydraulic drives, and requires minimal maintenance. Preferably, all wetted components of aerator 10 are made of stainless steel, including float 12 and uptake pipe 22. Float 12 may also be formed from reinforced fiberglass.

Aerator 10 may be maintained at a selected position on wastewater surface by securing cables or pipes to clasps 44, as best shown in Figures 1 and 4. Clasps 44 may be mounted on side surfaces 20 of float 12. Preferably, two clasps 44 are provided on side surfaces 20, and are perpendicular to the wastewater discharge flow. The cables may be secured to the sidewalls of the vessel or basin, or to an adjacent walkway or bridge. Alternatively, aerator 10 may be anchored to the bottom of the vessel, basin or pond. Preferably, the cables or pipes maintain aerator 10 at a determined position on wastewater surface 14, but allow aerator to rise or lower as the level of wastewater surface 14 fluctuates. In this way, aerator 10 may float on wastewater surface 14. Hinged pipes or tensioned cables may be used to maintain the positioning of aerator 10. Efficiency is achieved even during periods when fluid in the vessel is relatively low, or during peak flow periods, such as during heavy rains or contributory flows into the vessel.

Aerator 10 may be easily modified to account for the width of a particular vessel and/or the mixing pattern required for the geometry of the vessel. Such modification is accomplished by modifying the shape and orientation of directional baffles 34. Baffles 34 may be angled or curved relative to discharge outlet 42 so that the discharge pattern is either relatively wide or relatively narrow. The desired discharge pattern is determined based on system requirements and customer specifications. The orientation and curvature of baffles 34 may then be modified at the time of manufacture.

A directional aerator 50 according to another embodiment is best shown in Figure 6. Aerator 50 is similar to aerator 10, but includes directional baffles 52, as best shown in Figure 7. Each baffle 52 is U-shaped, and includes a first end 54 and a second end 56. The curvature of baffles 54 is relatively gradual, and not as sharp as the curvature of baffles 34. First ends 54 of baffles 52 extend from a central mounting rib 58, and curve around discharge outlet 42. Central mounting rib 58 extends from discharge outlet 42 to first ends 54, so that first ends 54 are spaced from discharge outlet 42.

Aerator 50 may also include at least one pair of directional mounting ribs 60. Directional mounting ribs 60 function in a similar manner to smaller baffle pair C in aerator 10. Directional mounting ribs 60 angle outwardly relative to discharge outlet 42, but need not parallel the angle of curvature of baffles 52. Directional mounting ribs 60 and central mounting rib 58 work in conjunction with directional baffles 52 to deflect the wastewater flow in a desired direction and discharge pattern, as best shown in Figure 8 by arrows F. The curvature of baffles 52, and the angle of directional mounting ribs 60 relative to discharge outlet 42 may be adjusted depending on system requirements.

Aerator 50 may also include an extended mounting rib 62, as best shown in Figures 6-10. Extended mounting rib 62 extends outwardly on first major surface 16 in line with the path of the wastewater being discharged. Extended mounting rib 62 may also be coplanar and in line with central mounting rib 58, wherein central mounting rib 58 extends from discharge outlet 42 to first ends 54 and extended mounting rib 62 extends in an opposite direction from discharge outlet 42. Extended mounting rib 62 balances aerator 50 by offsetting the weight difference created by baffles 52 on first major surface 16 of float 12.

An electrical cord-mounting bracket 64 may be secured to an end of extended mounting rib 62, proximate side surfaces 20 of float 12. A power supply cord C may be connected to electrical cord mounting bracket 64, aligned with extending mounting rib 62 and providing power to motor 32. Aerator 50 may float on wastewater surface 14 adjacent a walkway or bridge, aligned with the discharge flow. As such, the power supply cord C is aligned with, and easily attached to, electrical cord mounting bracket 64. In addition, electrical cord mounting bracket 64 provides that the power supply cord C is above the discharge flow.

Aerator 50 may also include a motor base plate 66, as best shown in Figures 6-10. Motor base plate 66 ensures that wastewater is deflected away from motor 32 upon discharge from discharge outlet 42, and outwardly from aerator 50 by baffles 52 in a desired direction. In this way, clogging and/or other damage to motor 32 is minimized.

Preferably, aerator 50 also includes an extended directional base plate 68, as best shown in Figures 6, 7 and 9. Extended directional base plate 68 is secured to and intermediate motor base plate 66 and baffles 52. Extended directional base plate 68 may

include a U-shaped inner edge 70, which aligns with discharge outlet 42, and an outer edge 72 aligned with baffles 54. Inner edge 70 may also be secured to, and overlap, directional mounting ribs 60 and central mounting rib 58. Extended directional base plate 68 deflects and channels wastewater flow against baffles 54 and ribs 58, 60, as best shown in Figure 10 by arrows F.

A controller C may be provided for controlling the volume of wastewater being discharged, as best shown in Figure 4. Aerator 50 (or 10) may be controlled to adjust for organic load (oxygen demand) fluctuations in the vessel by regulating the speed of aerator 50 (or 10). If a relatively heavy amount of flow is being input into basin B, the volume of wastewater being discharged may be adjusted accordingly by increasing the speed of aeration via controller C.

Controller C is preferably remote from aerator 50 (or 10), such as on a walkway or bridge adjacent the vessel being aerated. The controller may include a variable frequency drive ("VFD") that is in communication with oxygen meters in the vessel. The oxygen meters sense the dissolved oxygen level of the wastewater, and communicate the sensed information to the VFD via a 4-20 milliamp signal. The VFD controller may then regulate the oxygen requirements by increasing or decreasing the speed of aerator 50 (or 10). In this way, a selected dissolved oxygen level may be maintained, even if the hydraulic flow and organic load is variable.

Generally, the strength of wastewater is not variable. However, the hydraulic flow of wastewater into the aeration vessel (such as basin B) may fluctuate significantly depending on the time of day. An increase in hydraulic flow increases the organic load and demands an increased speed of oxygenation. The VFD may increase oxygenation by

speeding up aerator 50. This adjustment tends to match the oxygen level requirement to the organic demand caused by such increased hydraulic flows. Thus, the speed and volume of discharge from aerator 50 (or 10) is adjusted to either increase or decrease aeration. In this way, a selected dissolved oxygen level of the wastewater may be maintained based on the monitored levels.

Certain aspects of the present invention have been explained with reference to particular embodiments. However, it will be apparent to one of ordinary skill in the art that various modifications and variations may be made in construction or configuration of the present invention without departing from the scope or spirit of the invention. Therefore, it is intended that the present invention include all such modifications and variations provided they come within the scope of the following claims and their equivalents.